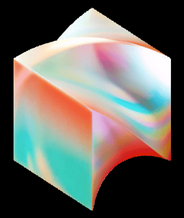


Lessons in Tackling IDE Performance

Pablo Baxter

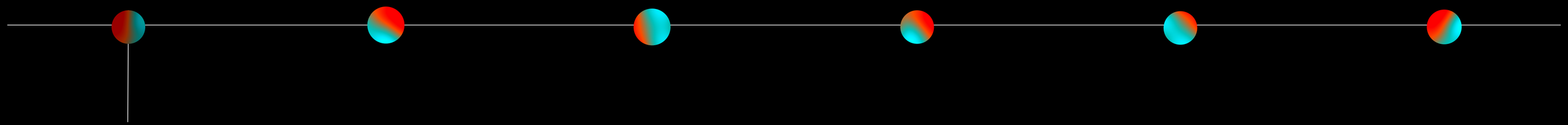
September 22, 2023

Why we care about the IDE

- IDE is the "last mile" (and often neglected?) of the developer experience!
- We couldn't find easily digestible information on the Internet about this topic.
- Hope you'll be able to use this knowledge to help improve the IDE experience for everyone!

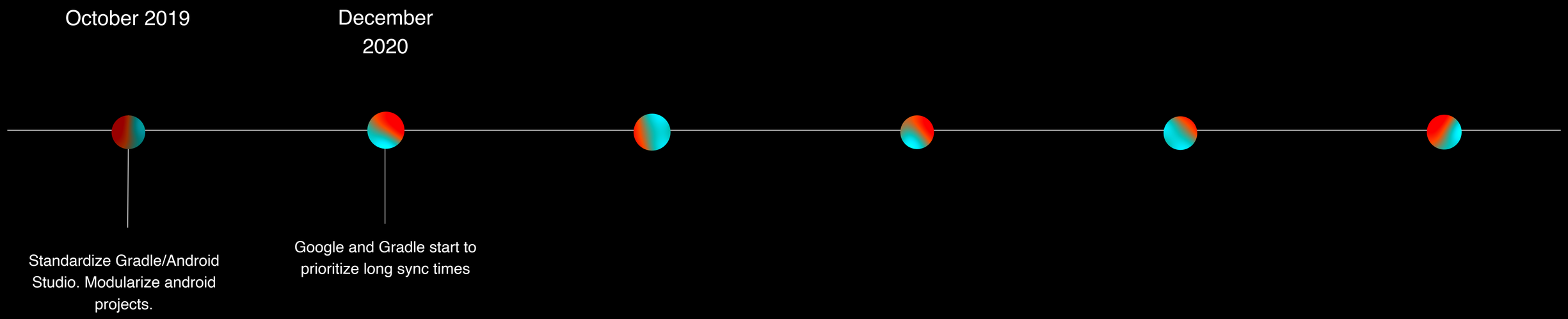
Quick History

October 2019

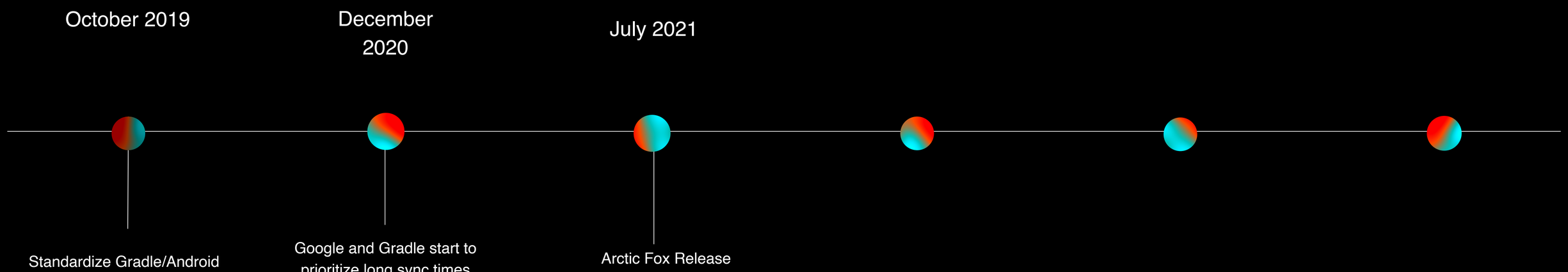


Standardize Gradle/Android Studio. Modularize android projects.

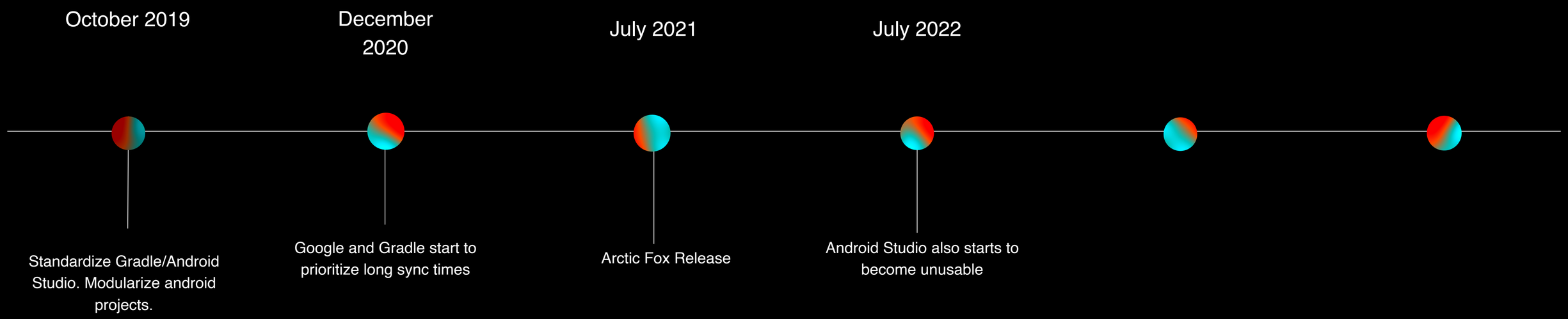
- In October 2019, we standardized on Android Studio and Gradle.
- We also decide to pursue code modularization. (Look up Ralf Wondratschek’s “Android at Scale @Square”, Droidcon’19)
  - Module count: ~1200



- Over the next few years, sync times worsened as our Gradle subprojects increased.
  - Module count: ~3500
- Google and Gradle start to prioritize sync times on Android Studio.



- Android Studio Arctic Fox released!
- Did not help with sync times as we had hoped
  - Module count: ~4000



- Pablo Baxter joins Block!
  - Module count: ~4600
- Android Studio becomes unusable for some developers

Problem #1: IDE freezes

- Developers began to complain that their IDE was unresponsive.
- This problem seemed to be so debilitating that people couldn't do their work.
- AGP v7.3 deprecated the “package” tag, “namespace” was going to be required.

```
<manifest xmlns:android="http://
schemas.android.com/apk/res/android"
package="com.example.myapp">

</manifest>
```



```
android {
    namespace = "com.example.myapp"
}
```

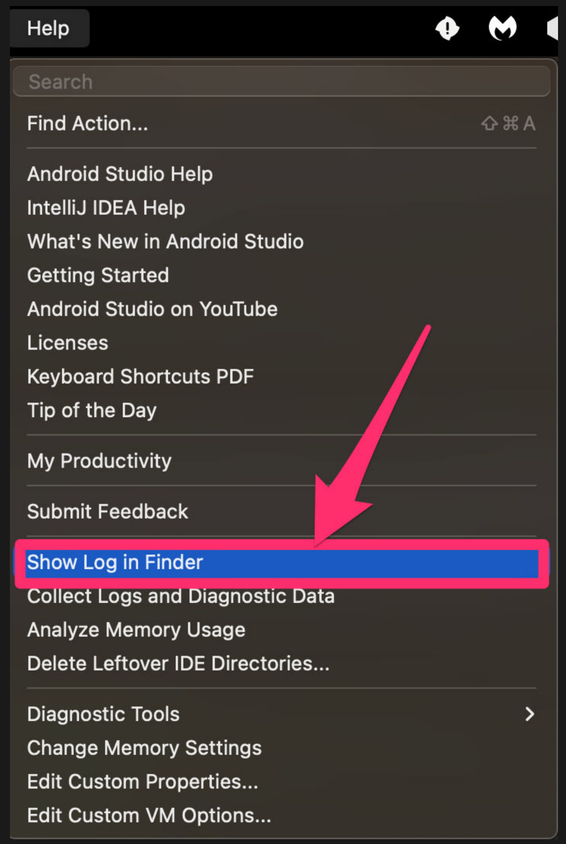
Inspecting the logs

- Noticed a particular message that seemed to be flooding the IDE.

```
2022-05-06 21:12:41,357 [89819248]   WARN - .idea.model.MergedManifestInfo -
getMergedManifestSupplier failed Manifest merger failed with multiple errors, see logs
2022-05-06 21:12:41,414 [89819305]   WARN - .idea.model.MergedManifestInfo -
getMergedManifestSupplier failed Manifest merger failed : Main AndroidManifest.xml at
AndroidManifest.xml manifest:package attribute is not declared
2022-05-06 21:12:41,521 [89819412]   WARN - .idea.model.MergedManifestInfo -
getMergedManifestSupplier failed Manifest merger failed with multiple errors, see logs
```

- Found a related Google ticket and asked about it.

- Reverted the change because the Android Studio wasn't quite ready for the AGP update.



https://issuetracker.google.com/issues/231704909

Lessons

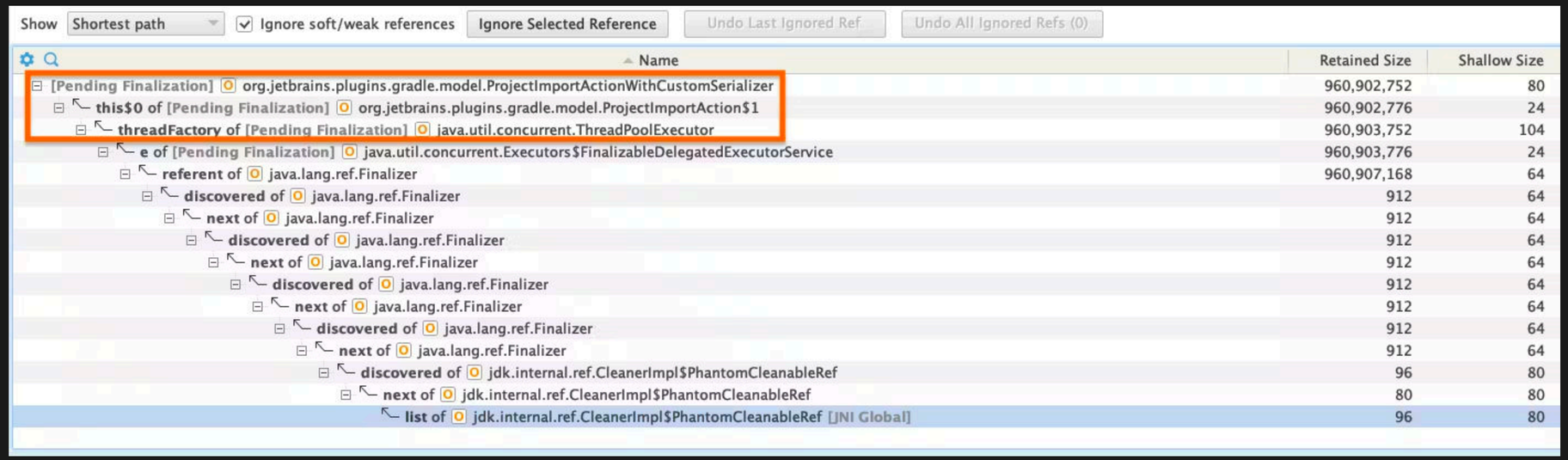
- The Android toolchain (AGP, Android Studio, Gradle) are often evolving independently.
- Ask your engineers for IDE logs when there are issues, especially if they are playing with canary versions.
- First exposure to understanding how these tools interact.

Problem #2: IDE Sync wasn't finishing

- Sync process seemed to be stalled.
- Gradle consuming too much memory on our laptops.
- Seemed to be showing up in canary versions only.

Chasing a memory leak

- Captured a heap dump and sent to py@
- Couldn't recompile Android Studio but realized we could byte-code patch it
- Retested with recompiling IntelliJ from source as well!



14 ...dle/tooling-extension-api/src/org/jetbrains/plugins/gradle/model/ProjectImportAction.java

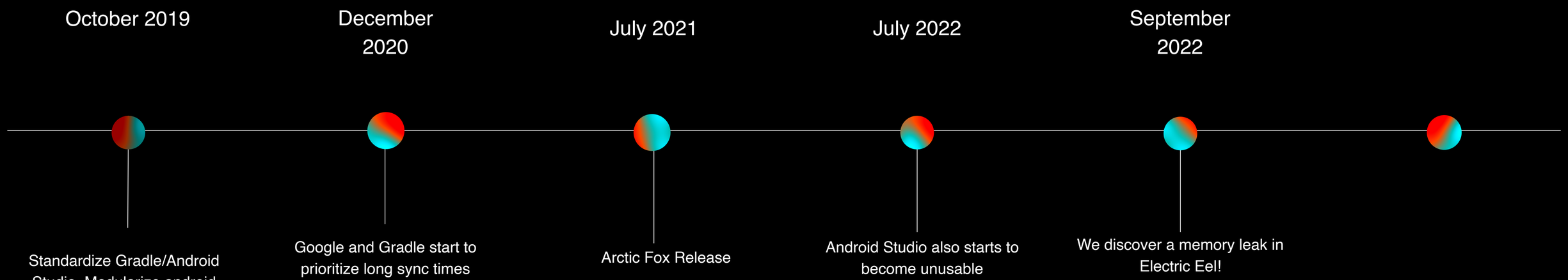
Viewed

```
@@ -111,12 +111,7 @@ public AllModels execute(final BuildController controller) {
111       myParallelModelsFetch = Boolean.getBoolean(IDEA_MODELS_PARALLEL_FETCH);
112     }
113     if (!System.getProperties().containsKey(IDEA_BACKGROUND_CONVERT) ||
    Boolean.getBoolean(IDEA_BACKGROUND_CONVERT)) {
114 -     myConverterExecutor =  Executors.newSingleThreadExecutor(new ThreadFactory() {
115 -       @Override
116 -       public Thread newThread(@NotNull Runnable runnable) {
117 -         return new Thread(runnable, "idea-tooling-model-converter");
118 -       }
119 -     });
120     }
121     configureAdditionalTypes(controller);
122     final boolean isProjectsLoadedAction = myAllModels == null &&
    myUseProjectsLoadedPhase;
@@ -717,4 +712,11 @@ public Object convert(Object object) {
717       return object;
718     }
719   }
720 }
```

```
111       myParallelModelsFetch = Boolean.getBoolean(IDEA_MODELS_PARALLEL_FETCH);
112     }
113     if (!System.getProperties().containsKey(IDEA_BACKGROUND_CONVERT) ||
    Boolean.getBoolean(IDEA_BACKGROUND_CONVERT)) {
114 +     myConverterExecutor =  Executors.newSingleThreadExecutor(new
    SimpleThreadFactory());
115     }
116     configureAdditionalTypes(controller);
117     final boolean isProjectsLoadedAction = myAllModels == null &&
    myUseProjectsLoadedPhase;
712       return object;
713     }
714   }
715 +
716 +   private static final class SimpleThreadFactory implements ThreadFactory {
717 +     @Override
718 +     public Thread newThread(@NotNull Runnable runnable) {
719 +       return new Thread(runnable, "idea-tooling-model-converter");
720 +     }
721 +   }
722 }
```

```
public static ExecutorService newSingleThreadExecutor() {
    return new FinalizableDelegatedExecutorService
        (new ThreadPoolExecutor(1, 1,
                                0L, TimeUnit.MILLISECONDS,
                                new LinkedBlockingQueue<Runnable>()));
}
```

```
 static class FinalizableDelegatedExecutorService
     extends DelegatedExecutorService {
     FinalizableDelegatedExecutorService(ExecutorService executor) {
         super(executor);
     }
     protected void finalize() {
         super.shutdown();
     }
 }
```



- PY talks about this memory in his blog
  - https://blog.p-y.wtf/gradle-intellij-memory-leak

- Roger Hu provides walkthrough on how to do bytecode patch using Recaf
  - https://rogerhu.github.io/studying-android-studio-internals/Patching-with-Recaf.html

Lessons

- Heap dumps are needed for tracking down memory issues.
- There are multiple places where problems can occur (Gradle daemon, IDE plugin, IDE code)
- Android Studio and IntelliJ are not that dissimilar
- Learned about bytecode patching JAR files with Recaf
- Thanks to Tony, PY and Roger for this fix!
  - https://github.com/JetBrains/intellij-community/pull/2186

Problem #3: IDE freezing again

- Memory leak eliminated!
- Namespace migration reverted!
- Now what?

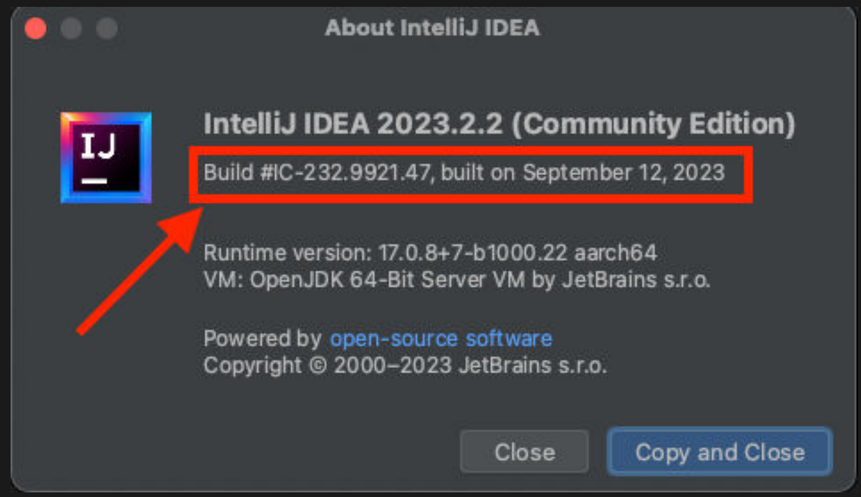
What if we could debug IDE?

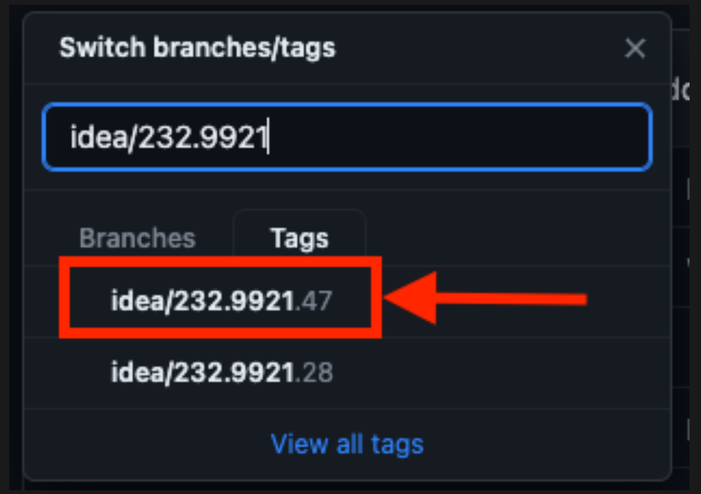
- Android Studio code isn't easily compilable (Bazel, internal libraries).
- Figured out we could do it with using IntelliJ open source
- Figured out how to attach breakpoints between Gradle or the IDE

How to attach a debugger for the IDE code to Gradle daemon

How to:

- Open the project you wish to debug
- Ensure the correct version is used

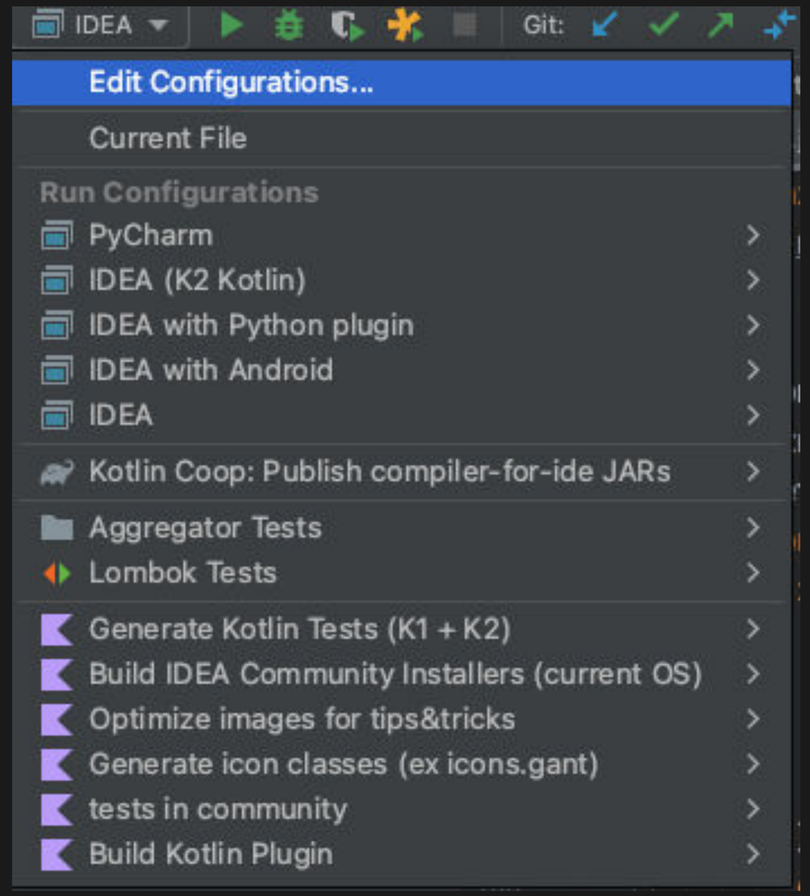




https://cs.android.com/android-studio/platform/tools/base/+/mirror-goog-studio-main:studio.md

How to:

- Open the project you wish to debug
- Ensure the correct version is used
- Add the configuration to the IDE



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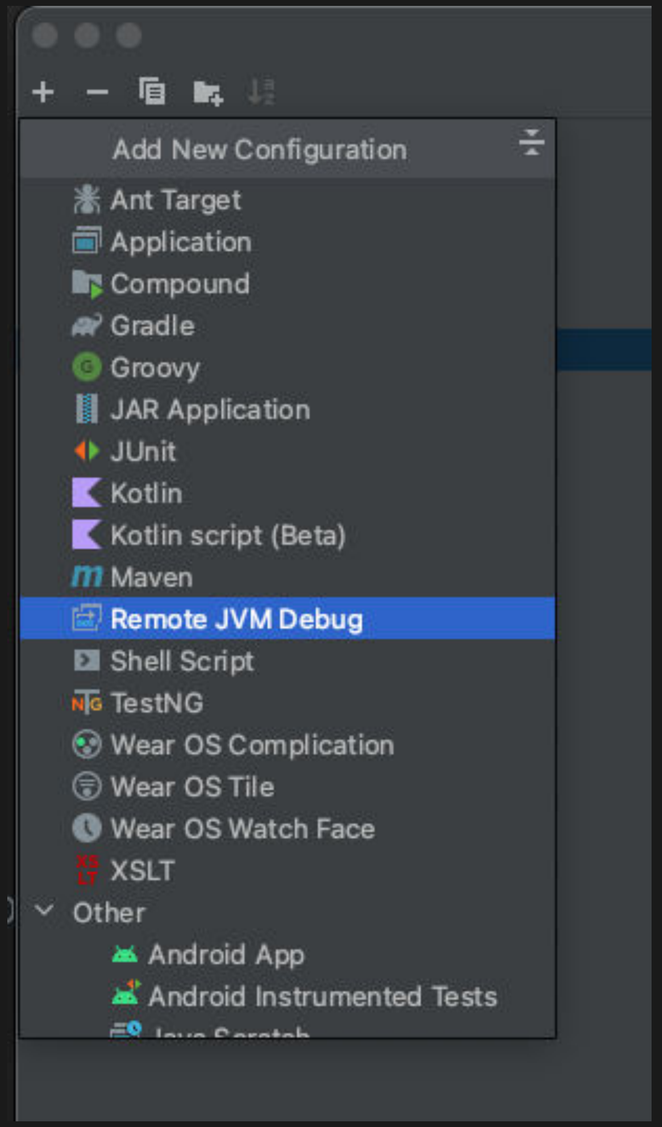

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- Open the project you wish to debug
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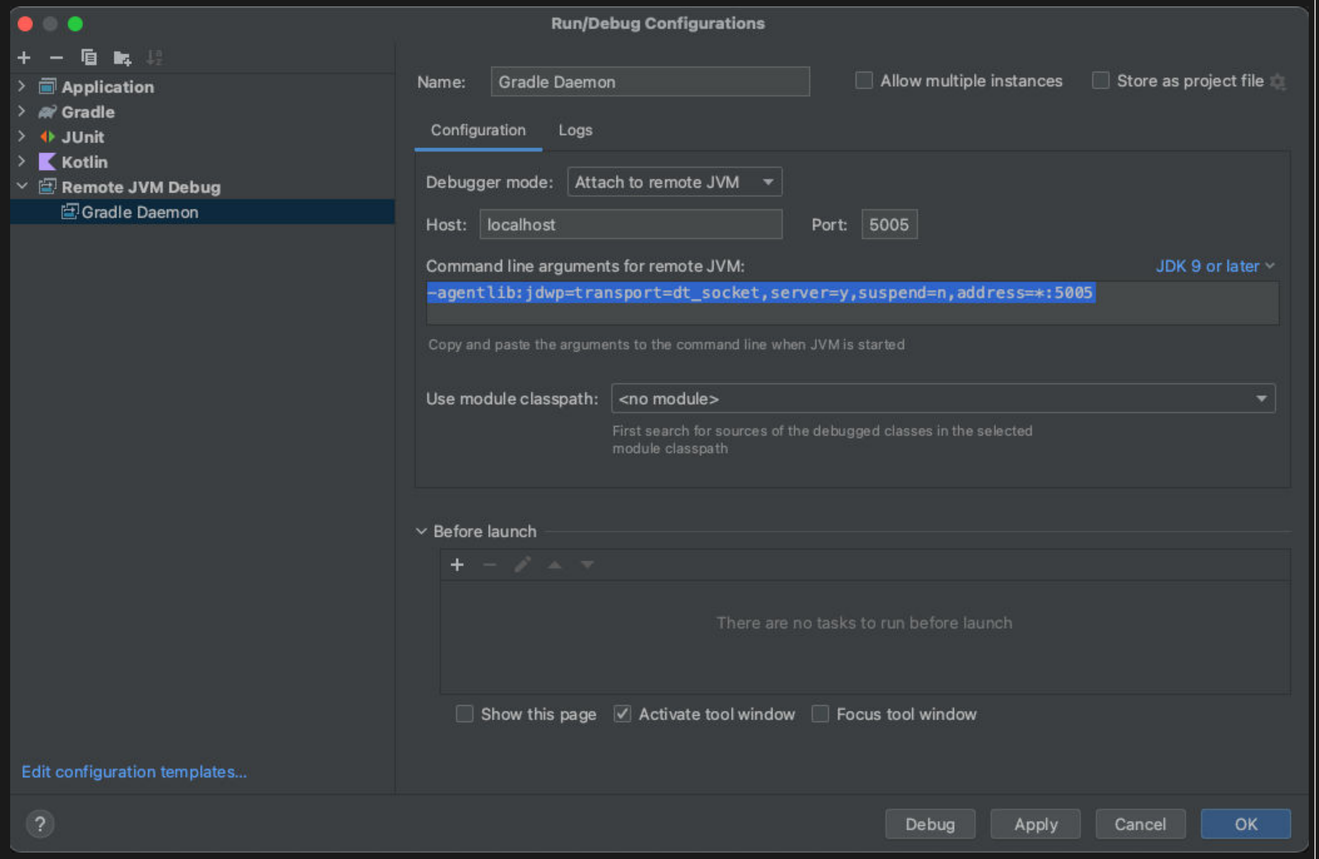
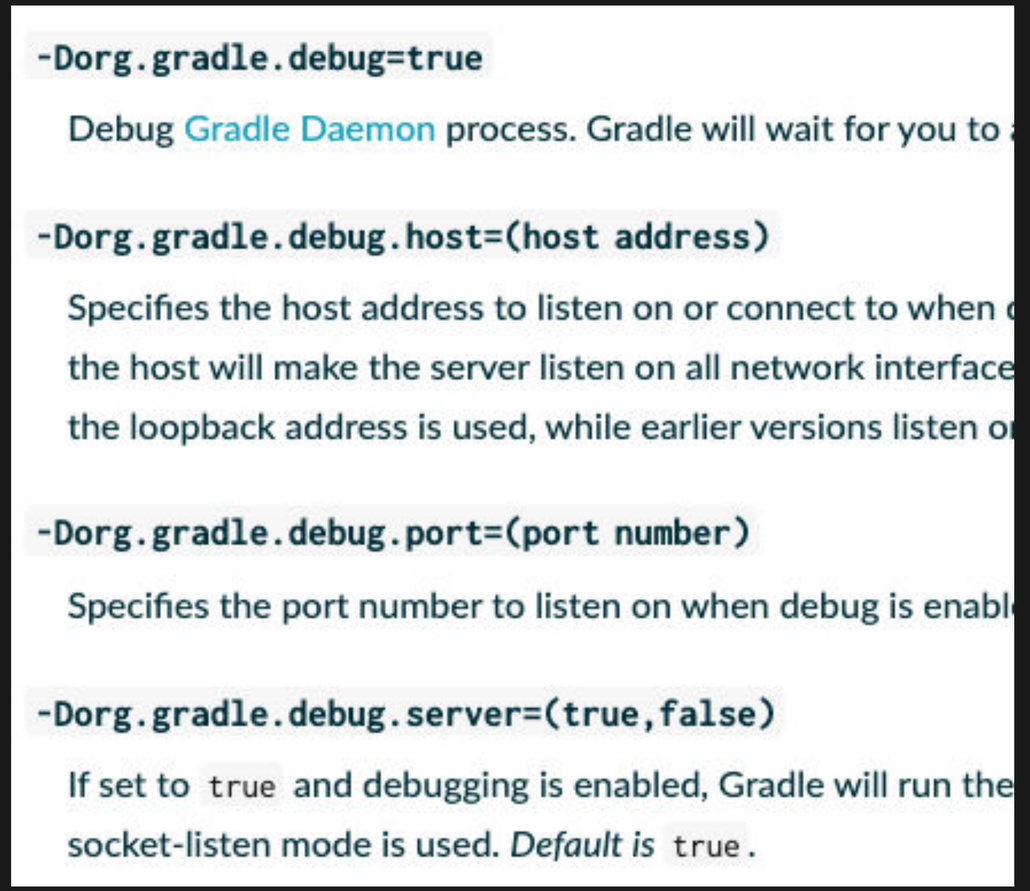


How to:

- Open the project you wish to debug
- Ensure the correct version is used
- Add the configuration to the IDE
- Start you Gradle task to debug with debugger flags



https://docs.gradle.org/current/userguide/command_line_interface.html#sec:command_line_debugging

How to debug IDE process:

- Roger Hu provided great walkthrough
  - https://rogerhu.github.io/studying-android-studio-internals/

Back to debugging problem #3

- Debugging showed call stack that repeated calls to the same function constantly
- IDE logs showed this same stacktrace in the thread dumps which are triggered when a UI freeze occurs
- Eventually found that ProjectFacetManagerImpl.getFacets() was excessively called

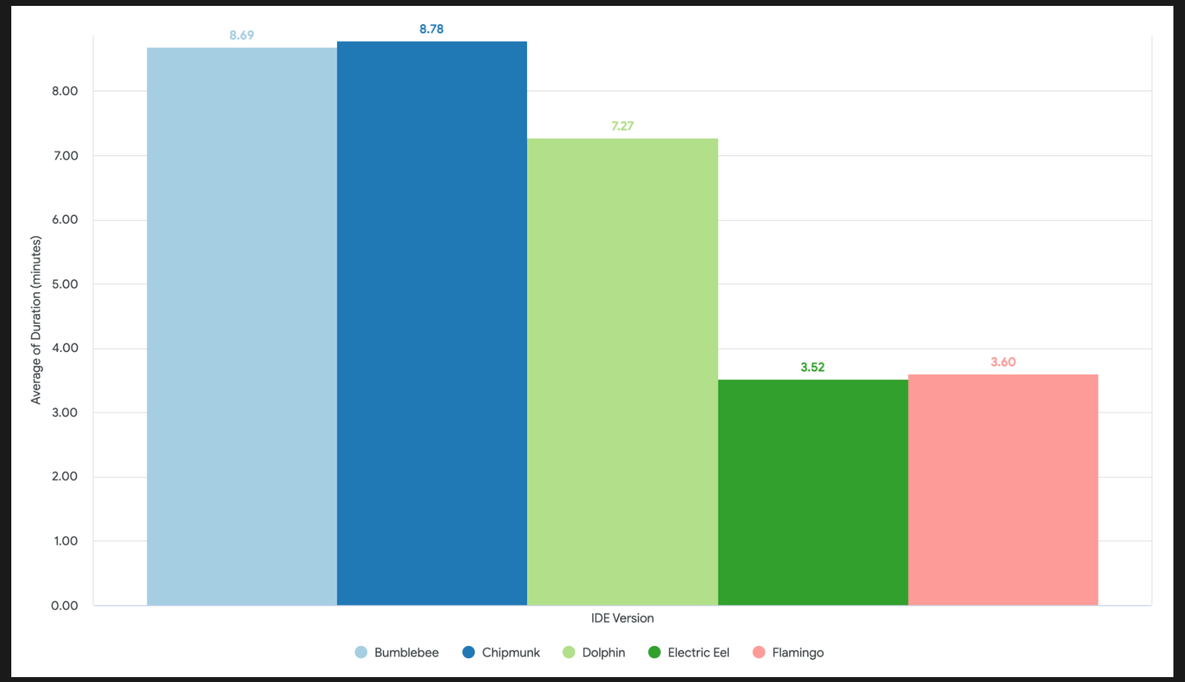
Back to debugging problem #3

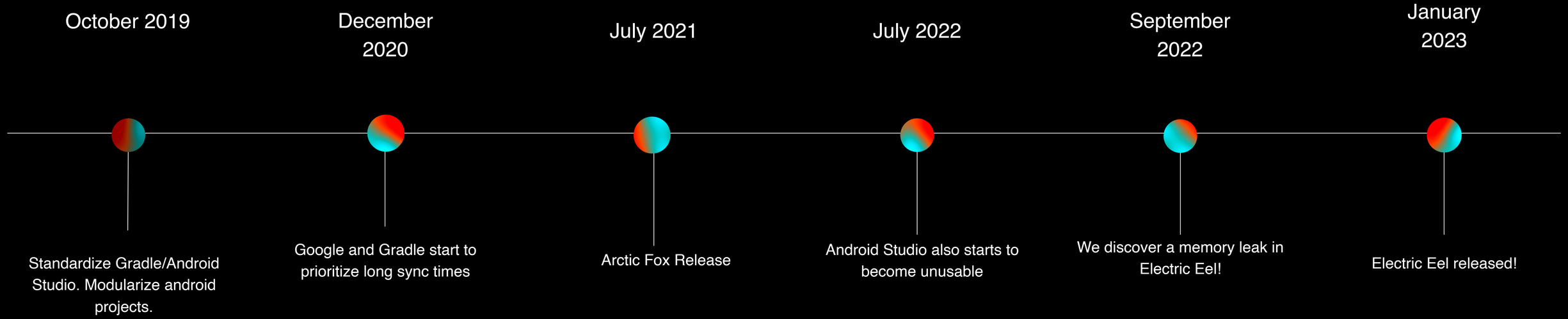
- Debugging showed call stack that repeated calls to the same function constantly
- IDE logs showed this same stacktrace in the thread dumps which are triggered when a UI freeze occurs
- Eventually found that ProjectFacetManagerImpl.getFacets() was excessively called

https://issuetracker.google.com/issues/248576926

How Google solved it

- Added a caching layer mapping package names to AndroidFacet objects
- Prevents allocation of thousands of arrays that each have thousands of elements each time the compiler front-end ran.
- Thank you Ivan Gavrilovic, Xavier Ducrohet, and team





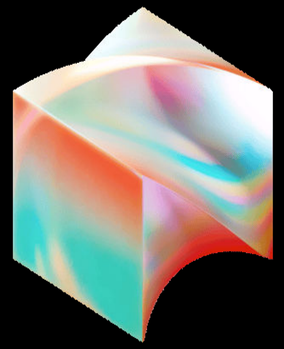
- https://developer.squareup.com/blog/celebrating-the-release-of-android-studio-electric-eel/
- https://newsletter.gradle.org/2023/01
- https://android-developers.googleblog.com/2023/01/android-studio-electric-eel.html

Lessons

- Debugging IDE code in both the Gradle and IDE processes
- IDE and Gradle source codes “intermingle”
- A well written bug report to the right group goes a long way

gavra@google.com
Block

Questions?



Thank You